CHEMICALS

Project Fact Sheet

Germanium Compounds As Highly Selective Fluorination Catalysts

New highly selective catalyst for the fluorination of hydrocarbons creates energy and cost savings

Benefits

- Saves energy through the enhanced conversion of chlorinated feedstock
- Permits fluorination under mild conditions
- Potential to reduce production of partially chlorinated by-products that are environmentally harmful
- Improves process safety by reducing pressure, thus reducing the risk of harmful intermediate compound release
- Eliminates or reduces production of toxic heavy-metal spent catalyst waste
- Offers energy savings through selectivity and ambient-condition reactions

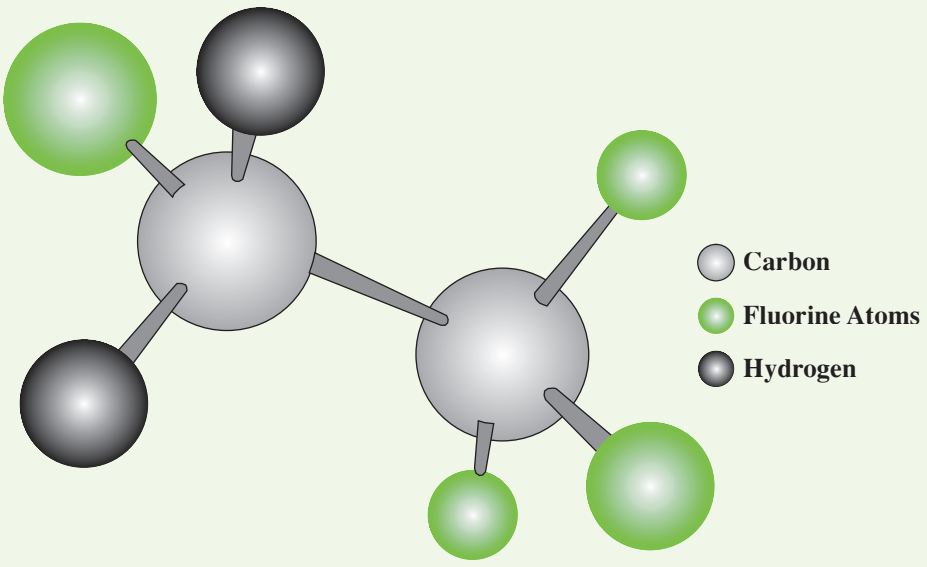
Applications

Potential applications for germanium compounds include fluoroform manufacture, teflon manufacture, conversion of existing CFC stockpiles, HFC production, and specialty chemical manufacture, including agricultural and pharmaceutical intermediates. In particular, this innovation simplifies and improves the production process for HFCs, including HFC-134a, the compound slated for use in most consumer refrigeration applications as a replacement for CFCs.

Fluorinated organic compounds are used in a large number of consumer products. One group of fluorinated compounds, known as hydrofluorocarbons (HFCs), has been determined to be an acceptable replacement for widely used, but ozone-depleting, chlorofluorocarbons (CFCs). However, efficient synthesis of HFCs on an industrial scale is challenging, due in part to the chemical properties of fluorine.

Current fluorinating processes, developed for the manufacture of CFCs, are not particularly suitable for the production of HFCs. Current methods tend to abstract hydrogen from the carbon backbone of the molecule, lowering yields of desirable HFCs and producing unwanted by-products that must be separated and recycled. Other processes employ milder reactions and avoid the unwanted by-products, but the reactions are slow and readily become deactivated.

Hydrofluorocarbon Molecule (HFC-134a)



One possible application of the new technology is in the manufacture of fluorocarbon compounds, such as HFC-134a, the CFC replacement compound currently used in automotive air conditioning systems.

A new technology uses germanium compounds as highly selective catalysts for the fluorination of chlorinated hydrocarbons under mild conditions, rather than at the currently required high temperature and high pressure. The germanium compounds are used to set up a catalytic cycle for rapid and efficient transfer of fluorine from low-cost sources.

Project Description

Goal: Demonstrate a new, highly selective catalyst for the fluorination of chlorinated hydrocarbons at room temperature and pressure.

This technology produces desirable compounds, such as HFC, by bringing a low-cost fluoride into contact with a chlorinated hydrocarbon in the presence of a germanium-bearing catalyst. The catalyst serves to promote the replacement of chlorine on the hydrocarbon with fluorine from its low-cost source. Because the fluorination is selective, the technology offers substantial process simplification and reduced energy consumption in the production of HFCs and other fluorocarbon molecules.

Germanium compounds will streamline HFC production, requiring less equipment while reducing environmentally harmful by-products and improving worker safety. In addition, this new method of HFC production is highly selective, eliminating the current need for post-processing operations such as separation and distillation. This selectivity, combined with reaction at ambient conditions, results in significant energy savings in the HFC production process. Starmet Corporation is developing this new technology with the help of a grant funded by the Inventions and Innovation Program in the Department of Energy's Office of Industrial Technologies.

Progress and Milestones

- Conduct proof-of-concept study for new, selective fluorination catalyst operating under mild conditions using two different low-cost fluoride sources.
- Demonstrate continuous process using the technology.

Economic and Commercial Potential

The potential for cost, energy, and environmental savings associated with germanium compounds as highly selective fluorination catalysts is significant. By allowing the fluorination process to take place in a rapid reaction under mild conditions, the catalyst is expected to improve the efficiency of HFC production and provide energy savings of 50 percent or more. In addition, successful demonstration of this technology using chlorinated feedstocks may also lead to the development of catalysts that use non-chlorinated feedstocks.

The use of this catalyst could be applicable to many manufacturing processes, equaling $2 billion in economic activity in the United States alone. For example, if the catalyst provides a 10 percent reduction in the cost of refrigerant manufacture, savings would comprise over $100 million per year in the United States. Even if this technology is only used in niche applications that currently use specialty fluorinating agents, such as those used in specialty chemical manufacture, the commercial savings of this catalyst could easily be tens of millions of dollars per year. Current industry and market trends indicate increasing markets for fluorinated compounds and fluoropolymers, offering huge commercial potential for this technology.

One significant challenge to the economic viability of this innovation is the high cost of germanium, approximately $500 per pound. However, if the catalyst can be recovered or regenerated with sufficient efficiency, this challenge can be met.

The Inventions and Innovation Program works with inventors of energy-related technologies to establish technical performance and to conduct early development. Ideas that have significant energy-savings impact and market potential are chosen for financial assistance through a competitive solicitation process. Technical guidance and commercialization support are also extended to successful applicants.

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